State Board of Education Approved
October 2001

DIGITAL ELECTRONICS

COURSE DESCRIPTION

Digital Electronics is a course in which students will construct and test fundamental digital logic circuits such as gates, counters, oscillators, and switches. A/D and D/A convertors will be applied to signal processing. Microcontroller programs will be modified and microcontrollers applied to closed-circuit control systems. The course culminates in a group project to create a digital servo control loop. Emphasis is on hands-on activities, real-world equipment, and current technology.

Prerequisites: **Algebra I or Math for Technology II; Programming and Logic (may be concurrent)**

Recommended Credits: **1**

Recommended Grade Level(s): **10th, 11th or 12th**

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DIGITAL ELECTRONICS STANDARDS

1.0 Students will demonstrate the use of gates and counters in logic circuits.

2.0 Students will demonstrate the use of oscillators in logic circuits.

3.0 Students will demonstrate the functions of and be able to operate switches and multiplexers in signal distribution.

4.0 Students will demonstrate the functions of and be able to operate analog and digital convertors.

5.0 Students will program and modify microcontrollers.

6.0 Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

DIGITAL ELECTRONICS

STANDARD 1.0

Students will demonstrate the use of gates and counters in logic circuits.

LEARNING EXPECTATIONS

The student will:
1.1 Construct logic circuits using gates.
1.2 Construct logic circuits using flip-flops, counters, and gates.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
1.1.A Analyzes the function of gates in logic circuits.
1.1.B Constructs logic circuits using AND, OR, NOR, and XOR gates as described by logic statements and schematic circuits
1.2.A Analyzes the function of flip-flops, counters, and gates in logic circuits.
1.2.B Constructs logic circuits using flip-flops, counters, and gates as described by given logic statements and schematic circuits.

SAMPLE PERFORMANCE TASKS

- Create a circuits wing AND,OR, NOR, and XOR gates to execute given Boolean expressions based on several inputs.
- Create circuits using flip-flops to act as a counter.
- Create a circuit using flip-flops to make a four digit binary to decimal converter.

INTEGRATION/LINKAGES

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Mathematics concepts and skills. Computer Science concepts and skills.

DIGITAL ELECTRONICS

STANDARD 2.0

Students will demonstrate the use of oscillators in logic circuits.

LEARNING EXPECTATIONS

The student will:
2.1 Examine the functions of RC (resistor and capacitor) and crystal-controlled oscillators.
2.2 Construct RC and crystal-controlled oscillators.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
2.1.A Analyzes the purpose and functions of RC and crystal-controlled oscillators.
2.1.B Generates examples of uses of oscillators.
2.2.A Interprets schematics containing oscillator circuits.
2.2.B Constructs RC and crystal-controlled oscillators based on schematics.

SAMPLE PERFORMANCE TASKS

- Build an oscillator circuit (RC) to provide a clock signal.
- Build an oscillator circuit (crystal-controlled) to provide a precision clock signal.
- Build a multitone oscillator system (organ).
- Build a tone generator for signal tracing.

INTEGRATION/LINKAGES

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Mathematics concepts and skills. Computer Science concepts and skills.

DIGITAL ELECTRONICS

STANDARD 3.0

Students will demonstrate the functions of and be able to operate switches and multiplexers in signal distribution.

LEARNING EXPECTATIONS

The student will:
3.1 Use digitally controlled analog switches to control analog and digital signal distribution.
3.2 Use analog switches to perform multiplexing functions.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
3.1.A Explains and demonstrates the features and functions of digitally controlled analog switches.
3.1.B Applies digitally controlled analog switches to control analog and digital signal distribution as described by schematic circuits.
3.2.A Identifies desired multiplexing functions.
3.2.B Groups analog switches to perform the desired multiplexing functions.

SAMPLE PERFORMANCE TASKS

- Create a circuit that serves as a synchronous detector.
- Construct an eight-channel analog multiplexer using discrete components.
- Build a circuit to turn on a rectangular array of LEDs (light-emitting diodes) to display alphanumeric characters.

INTEGRATION/LINKAGES

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Mathematics concepts and skills. Computer Science concepts and skills.

DIGITAL ELECTRONICS

STANDARD 4.0

Students will demonstrate the functions of and be able to operate analog and digital convertors.

LEARNING EXPECTATIONS

The student will:
4.1 Compare and contrast analog and digital data.
4.2 Determine sampling rates required for input signals.
4.3 Interpret and create block diagrams of D/A (digital/analog) and A/D convertors.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
4.1.A Distinguishes the characteristics of analog versus digital data.
4.1.B Explains the consequences of choices at level of quantization (sample rate, number of bits, etc.).
4.2.A Evaluates sampling rates.
4.2.B Determines the minimum sampling rate required for an input signal of known maximum frequency.
4.3.A Draws block diagrams of successive approximation D/A convertors.
4.3.B Draws block diagrams of successive approximation A/D convertors.

SAMPLE PERFORMANCE TASKS

- Display on an oscilloscope simultaneously the analog input and serial digital output of a A/D converter.
- Observe efforts of sampling rate at an A/D-D/A pair on the analog signal in and out.
- Determine suitability of a converter based on block diagrams and specifications for an application such as audio conversion.

INTEGRATION/LINKAGES

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Mathematics concepts and skills. Computer Science concepts and skills.

DIGITAL ELECTRONICS

STANDARD 5.0

Students will program and modify microcontrollers.

LEARNING EXPECTATIONS

The student will:
5.1 Use and modify microcontroller features.
5.2 Explore microcontroller support devices.
5.3 Program microcontrollers.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
5.1.A Describes and explains the basic features of microcontrollers.
5.1.B Uses a high-level computer language and compiler to debug and modify existing microcontroller programs to achieve desired results.
5.2.A Identifies typical peripheral chips and devices used to support microcontrollers, such as memory, display, and signal interface chips.
5.2.B Illustrates the functions of typical peripheral chips and devices used to support microcontrollers.
5.3.A Constructs and programs computational algorithms on breadboarded microcontrollers to read and display analog and digital input.
5.3.B Modifies input signals to create desired outputs (digital and/or analog).
5.3.C Creates servo controls for a given purpose.

SAMPLE PERFORMANCE TASKS

- Modify an existing numerically-controlled program to accomplish a minor change in result.
- Design and program a microcontroller temperature control circuit for an industrial oven to follow a specified temperature profile.

INTEGRATION/LINKAGES

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Mathematics concepts and skills. Computer Science concepts and skills.

DIGITAL ELECTRONICS

STANDARD 6.0

Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

LEARNING EXPECTATIONS

The The student will:
6.1 Demonstrate dignity in work.
6.2 Participate in SkillsUSA-VICA as an integral part of classroom instruction.
6.3 Evaluate school, community, and workplace situations by applying problem-solving and decision-making skills.
6.4 Demonstrate the ability to work professionally with others.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
6.1.A Demonstrates attitudes conducive to success, through exhibiting characteristics of honesty, integrity, flexibility, adaptability, patience, objectivity, tolerance, perseverance, and initiative.
6.1.B Researches the Internet for continuing education in an appropriate industry.
6.2.A Compares the relationship between work ethics and personal job success.
6.2.B Presents information valuable to consumers to school, community, and professional groups.
6.3 Analyzes situations in the workplace and uses problem-solving techniques to solve and create a desirable environment.
6.4.A Participates in job shadowing.
6.4.B Manages an officer or national voting delegate campaign with Tennessee SkillsUSA-VICA.

SAMPLE PERFORMANCE TASKS

- Students prepare a resume.
- Students develop a plan for continuing education in the digital electronics industry.
- Students create a chart showing personal goals for future growth in the industry.
- Students participate in various SkillsUSA-VICA programs and/or competitive events.
- Students attend a professional organization meeting.
- Students participate in the American Spirit Award competition with SkillsUSA-VICA.
- Students develop a plan of action for an officer candidate or national voting delegate.
- Students participate in job shadowing or internship in the manufacturing industry.

INTEGRATION /LINKAGES

SkillsUSA-VICA, *Professional Development Program*, SkillsUSA-VICA, Communications and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Math, Math for Technology, Applied Communications, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies

DIGITAL ELECTRONICS

SAMPLING OF AVAILABLE RESOURCES

Digital Electronics: Principles and Applications. Glencoe, 1999.
Digital Electronics: A Simplified Approach. Prentice-Hall, 2001.
Digital Systems: Principles and Applications. Prentice-Hall, 2001.
Practical Approach to Digital Electronics. Prentice-Hall, 2000.
First Course in Digital Electronics. Prentice-Hall, 1999.
Introductory Digital Electronics. Prentice-Hall, 1998.